Report

Emission Rate Lookup Table Efficacy Report for Mobile Source Air Toxics and Criteria Pollutants

TxDOT Environmental Affairs Division
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1.0 BACKGROUND

Mobile source air toxics (MSAT) are compounds known or suspected to cause cancer or other serious health and environmental effects. The Environmental Protection Agency (EPA) has assessed an expansive list in their rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS)[1,2]. The EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers from the 2011 National Air Toxics Assessment (NATA)[3]. These are *acetaldehyde (ACTE), acrolein (ACROL), benzene (BENZ), 1,3-butadiene (BUTA), diesel particulate matter plus diesel exhaust organic gases (DPM), ethylbenzene (ETYB), formaldehyde (FORM), naphthalene (NAP), and polycyclic organic matter (POM).* While the Federal Highway Administration (FHWA) considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

According to FHWA rules and guidance and Texas Department of Transportation (TxDOT) guidance for addressing National Environmental Policy Act (NEPA) requirements, environmental documentation for specific categories of transportation projects that require federal action should include a qualitative or quantitative MSAT analysis[4]. The FHWA has developed updated interim guidance regarding when and how to analyze MSAT in the NEPA process for highway projects[5]. Consistent with the FHWA Interim MSAT Guidance as implemented by TxDOT, a quantitative MSAT analysis is required for projects located in proximity to populated areas that have an annual average daily traffic (AADT) volume greater than or equal to 140,000[6] or that create or significantly alter a major intermodal freight facility involving significant numbers of diesel vehicles. Quantitative MSAT analysis involves estimating emission factors, identifying roadway links that have changed, and calculating emissions for the roadway links identified in the process for different analysis years. FHWA recommends considering changes in the following metrics between build and no-build scenarios to define the affected transportation network for MSAT analysis:[7]

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[1] https://www.epa.gov/mobile-source-pollution/final-rule-control-hazardous-air-pollutants-mobile-sources

[2] https://www.epa.gov/iris/basic-information-about-integrated-risk-information-system

[3] https://www.epa.gov/national-air-toxics-assessment

[4] http://www.txdot.gov/inside-txdot/division/environmental/compliance-toolkits/air-quality.html

[5] https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/2016msat.pdf

[6] https://ftp.txdot.gov/pub/txdot-info/env/toolkit/230-01-gui.pdf

[7] https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/moves_msat_faq.cfm

- +/- 5 percent change in annual daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;
- +/- 10 percent change in AADT on uncongested highway links of LOS C or better;
- +/- 10 percent change in travel time; and
- +/- 10 percent change in delay.

The FHWA has identified in its Technical Advisory Guidance for Preparing and Processing Environmental and Section 4(f) Documents (T 6640.8A) that a project-level carbon monoxide traffic air quality analysis (CO TAQA) may be necessary in order to comply with NEPA requirements. The CO TAQA assesses whether the project would adversely affect local air quality by contributing to CO levels that exceed the 1-hour or 8-hour CO National Ambient Air Quality Standards (NAAQS). This affects all added capacity projects, where the project corridor meets the minimum traffic volume threshold.[8]

The Clean Air Act Amendments of 1990 (CAAA) requires the EPA to set NAAQS (40 Code of Federal Regulations; CFR, Part 50) for pollutants considered harmful to public health and the environment, including six principal pollutants, which are called "criteria air pollutants." These are ozone (O_3), carbon monoxide (CO), particulate matter (PM), nitrogen dioxides (NO_2), sulfur dioxide (SO_2), and lead (Pb). The criteria pollutants can be used to estimate emissions for grant applications and other various planning purposes. However, it is recommended to contact the Metropolitan Planning Organizations where the project resides to get the latest emission rates.

The emission rate lookup tables (ERLT) are developed for MSAT and criteria pollutants for eight Texas metropolitan geographic areas, including Austin, Beaumont, Corpus Christi, Dallas & Fort Worth, El Paso, Houston, San Antonio, and Waco. The ERLT was developed using the data and assumptions documented in the pre-analysis consensus plan. These tables provide emission rates for MSAT, which include ACTE, ACROL, BENZ, BUTA, DPM, ETYB, FORM, NAP, and POM. The tables also include rates for criteria pollutants such as CO, PM_{10}, $PM_{2.5}$, SO_2, NO_2, oxides of nitrogen (NO_X), volatile organic compounds (VOC), and carbon dioxide equivalent (CO_{2Eq}). The ERLT deliverables include the following rates tables:

1. Annual maximum daily running exhaust emissions for MSAT and criteria pollutants (Running ERLT).
2. Annual maximum daily idling exhaust emissions for MSAT and criteria pollutants (Idling ERLT).
3. Annual maximum daily extended idling[9] exhaust emissions for MSAT and criteria pollutants for 18-Wheeler vehicles (Motor Vehicle Emission Simulator (MOVES) vehicle type 62) (Extended Idling ERLT).
4. Annual maximum daily start exhaust emissions for MSAT and criteria pollutants for all vehicle types (Start ERLT).

[8] https://www.environment.fhwa.dot.gov/legislation/nepa/guidance_preparing_env_documents.aspx#aq

[9] The extended idling ERLT is only applicable for combination long-haul trucks (18-wheelers).

2.0 APPLYING EMISSION RATE FOR PROJECTS

This section briefly describes the application of the ERLT (running, idling, extended idling, and start) described in the previous section to estimate emissions for the following requirements.

1) Quantitative MSAT network emission calculations
2) CO emissions for Transportation projects
    a. CO TAQA free flow link emission calculations
    b. CO TAQA idling link emission calculations
3) Idling emissions for MSAT and criteria pollutants
4) Extended idling ERLT for MSAT and criteria pollutants
5) Start ERLT for MSAT and criteria pollutants

2.1 QUANTITATIVE MSAT NETWORK EMISSION CALCULATIONS

Quantitative MSAT analysis involves developing emission factors, identifying affected transportation network roadway links, and calculating emissions for the affected transportation network for different analysis years, and build/no-build scenarios. The running ERLT provides MSAT emission rates for MSAT analysis, which includes ACE, ACROL, BENZ, BUTA, DPM, ETB, FORM, NAP, and POM. These rates can be used for estimating emissions for transportation projects that require quantitative MSAT analysis. The emission rates in the ERLT are in grams/mile.

For calculating emissions for MSAT, the formula is:

$$\textit{Emissions (lbs/day)}_{\textit{Speed, roadway type}} = \textit{Emission Rate}_{\textit{Speed, Roadway Type}}\ \textit{(grams/mile)} * \textit{Vehicle Miles of Travel (miles/day)} * 1\ \textit{lb}/453.59237\ \textit{grams}$$

Where VMT on a specific link at modeled speed = Volume * Link Length.

2.1.1 Example for Estimating MSAT Emissions

For quantitative MSAT analysis, pollutant emission rates are required for each roadway link in the affected network. Table 1 shows the project description which includes analysis year, roadway type, length, and link-level speed and volume needed for estimating MSAT emissions for build and no-build scenarios.

Table 1. Link Input for Quantitative MSAT Emissions Calculation.

Inputs	Values	Units
District	Dallas	-
Horizon Year	2040	-
Roadway Type	Urban Restricted Access	-
Annual Average Daily Traffic (AADT) for Build and No-build Scenario	215,000	vehicles
Link Length*	0.5*	miles
Daily Vehicle Miles of Travel (DVMT)*	107,500*	vehicle-miles
Daily No-Build Average Speed	58	mph
Daily Build Average Speed	63	mph

*Link length and DVMT are independent for each link in the affected network.

Based on the information in Table 1, select the "Dallas" tab in the running ERLT excel worksheet and filter the table to only keep the MSAT pollutant values for the year 2040, roadway type of Urban Restricted Access, and the average speeds 58 and 63 mph. The build and no-build emission rates are applied separately for each link in the MSAT analysis.

The link-level MSAT pollutant emissions can be estimated using link specific speed and roadway MSAT ERLT in the following equation:

Emissions (lbs/day) $_{\textit{Speed, Roadway Type}}$ ***= Emission Rate*** $_{\textit{Speed, Roadway Type}}$ ***(grams/mile) * (215,000 * 0.5) (miles/day) *1 lb/453.59237 grams***

Table 2 shows the emission rates from the filtered running ERLT for MSAT and presents the total link emissions for each pollutant in grams/day. This process should be repeated for all links in the affected transportation network for the build and no-build scenario.

Table 2. Build and No-Build Quantitative MSAT Link Emission Calculations.

Pollutant	No-Build Emission Rate[(a)]	Build Emission Rate[(b)]	DVMT[(c)]	No-Build Emissions [(d)]	Build Emissions[(d)]
BENZ	0.0002283	0.0002386	107,500	24.5	25.6
NAPTH	0.0000473	0.0000449	107,500	5.1	4.8
BUTA	0.0000019	0.0000018	107,500	0.2	0.2
FORM	0.0005824	0.0005467	107,500	62.6	62.6
ACROL	0.0000269	0.0000253	107,500	2.9	2.9
DPM	0.0012388	0.0012210	107,500	133.2	133.2
POM	0.0000117	0.0000119	107,500	1.3	1.3
ACTE	0.0001922	0.0001814	107,500	20.7	20.7
ETYB	0.0001938	0.0001891	107,500	20.8	20.8

(a) Dallas 2040 *Urban Restricted Access* roadway ERLT for MSAT emission rates (grams/mile) at 58 mph.
(b) Dallas 2040 *Urban Restricted Access* roadway ERLT for MSAT emission rates (grams/mile) at 63 mph.
(c) Based on link AADT and length. The VMT may be different for build and no-build
(d) Emissions are in grams/day

2.2 Estimating CO Emissions for Transportation Projects

A CO TAQA is developed through the use of two different models, an emissions model and a dispersion model. The current EPA approved latest emissions model is MOVES2014b and the current approved EPA dispersion models for Texas are either CALINE3 or CAL3QHC. CALINE3 is for projects that are considered free-flow and CAL3QHC is for projects that have major congested intersections. The emission rates obtained from the MOVES model will be used in the appropriate dispersion model to identify the specific concentration of CO at the applicable receptor locations.[10]

For total emissions on free flow roadways without major intersections, CO emission rates are applied separately for each modeled link in the CALINE3 model. For total CO emissions on roadways with major intersections, the estimations will require both free flow emission rates for each link modeled as well as an idling emission factor. Free flow CO emission rates are applied separately for each free flow link in the CAL3QHC model and idling CO emission rates are applied to each queue link in the CAL3QHC model.

The annual maximum CO ERLT (grams/mile) is used in the CO TAQA analysis.

[10] TxDOT, 2016, *Useful Information: Carbon Monoxide (CO) Traffic Air Quality Analysis (TAQA) Emission Rate Lookup Tables (ERLT)*, TxDOT Environmental Affairs Division, Effective Date: June 2016 220.01.GUI. Version 1, https://ftp.txdot.gov/pub/txdot-info/env/toolkit/220-01-gui.pdf.

2.2.1 CO TAQA Free Flow Link Emissions Calculations

For CO TAQA free-flow link emission calculations, the formula for estimating the CO emissions is:

Emissions (lbs/day)** $_{\textit{Speed, Roadway Type}}$ **= Emission Rate** $_{\textit{Speed, Roadway Type}}$ **(grams/mile) * Vehicle Miles of Travel (miles/day) * 1 pound/453.59237 grams

Where VMT on a specific link at modeled speed = Volume * Link Length.

Example for estimating CO TAQA Free-Flow Link Emissions

A city in Dallas plans to increase the capacity of an urban freeway (urban restricted access). The project is anticipated to have an AADT of 215,000 vehicles. The project would be finished by Fall 2023. Table 3 shows the project details needed to find the appropriate link-level CO emission rate using the ERLT for TAQA.

Table 3. Link Input for CO TAQA Free-Flow Emissions Calculation.

Inputs	Values	Units
District	Dallas	-
Analysis Year	2023	-
Road Description	Urban Restricted Access	-
Annual Average Daily Traffic (AADT)	215,000	vehicles
Roadway Link Length	0.5	miles
Daily Post-project Average Speed	63	mph

For CO TAQA modeling, a CO emission rate is required for each roadway link considered in the analysis. Based on information in Table 3, select the “Dallas” tab in the running ERLT excel worksheet and filter the table to only keep the CO values for the year 2023, roadway type of Urban Restricted Access, and the average speed of 63 mph. The CO emission rate is applied separately for each link in the CALINE3 model.

The link-level CO Emissions can be estimated using the link specific speed and roadway CO ERLT extracted in the following equation:

Emissions (lbs/day)** $_{\textit{63, Urban Freeway}}$ **= Emission** $_{\textit{63, Urban Freeway}}$ **(grams/mile) * (215,000 * 1.5) (miles/day) * 1 pound/453.59237 grams

Table 4 shows the emission rates from the filtered ERLT for CO TAQA and presents the total link CO emissions in grams and pounds/day.

Table 4. CO TAQA Free-Flow Link Emission Calculations.

Area	Year	Road Description	Average Speed (mph)	CO Emission Rate (grams/mile)	Link Length (mile)	VMT*	Total Link CO Emissions (gram)	Total Link CO Emissions (lbs/day)
DFW	2023	Urban Restricted Access	63	1.562209187	0.5	107,500	167,937.5	370.2

*Based on link length in analysis.

2.2.2 CO TAQA Idling Link Emission Calculations

For CO TAQA idling link emission calculations, the formula for estimating idling emissions is:

Emissions (grams/analysis period) =
Emission Rate (grams/hour) * Idling time (hours/analysis period)

An example calculation is provided below to demonstrate the application of the idling emission rates for quantifying the emission for CO TAQA.

Example for Estimating CO TAQA Idling Link Emissions

A city in Dallas plans to increase the capacity of an urban arterial roadway with a major intersection. The project is anticipated to have an AADT of 40,000 vehicles. The project would be finished by Fall 2023. Table 5 shows the project details needed to find the appropriate CO emission rate from the ERLT for TAQA.

Table 5. Link Input for CO TAQA Free-Flow Emissions Calculation.

Inputs	Values	Units
District	Dallas	-
Analysis Year	2023	-
Roadway Type	Urban Unrestricted Access	-
Annual Average Daily Traffic (AADT)	40,000	vehicles/day
Vehicle Idling Time at the Intersection	150	hours/day
Roadway Link Length	0.5	miles
Intersection Queue Length	0.2	miles
Daily Post-project Average Speed	52	mph

For CO TAQA modeling, select the “Dallas” tab in the running ERLT excel worksheet and filter the table to only keep the CO values for the year 2023, roadway type of Urban Unrestricted Access, and. the average speeds of 52 mph. For queue length, select the “Dallas” tab in the idling ERLT excel worksheet filter the table to only keep the CO values for the year 2023.

Table 6 shows the emission rates from the filtered ERLT for CO TAQA and presents the total link CO emissions in grams and pounds/day.

Table 6. CO TAQA Idling and Free Flow Link Emission Calculations.

Area	Year	Roadway Type	Average Speed (mph)	CO Idling Emission Rate	Link Length (mile)	Activity *	Total Link CO Emissions (gram)
DFW	2023	Urban Unrestricted Access	52	1.05389	0.5	20,000	29,930.3
			Idling	4.60624	0.2	150	536.3

*Free-flow speed activity is in vehicle miles of travel (miles/day) and idling activity is represented in hours of delay (hours/day) at the intersection.

2.3 Idling Emissions for MSAT and Criteria Pollutants

The idling ERLT provides emission rates for MSAT and criteria pollutants. The criteria pollutants can be used to estimate emissions for grant applications and other various planning purposes. However, it is recommended to contact the MPOs where the project resides to get the latest emission rates. The units of rates are grams/hour. It can be used to estimate emissions using the following formula:

Emissions (grams/analysis period) =
Emission Rate (grams/hour) * Idling time (hours/analysis period)

An example calculation is provided below to demonstrate the application of the idling exhaust emission rates for quantifying the emission for a project.

2.3.1 Example for Estimating Idling Emissions

Consider a project to improve operations at an isolated intersection in the Dallas district by switching the intersection from pre-timed to actuated control using advanced detectors. Table 7 presents the project information. The project would be completed in the fall of 2021. The majority of the operational benefits are experienced during the AM and PM peak periods from 6-9 am and 4-7 pm. Traffic operation analysis show pre-project AM and PM peak periods total delay is 65 vehicle-hours and post-project AM and PM peak periods total delay is 30 vehicle-hours. Post-project emission reduction estimates are required for criteria pollutants and MSAT for the build year during the peak periods.

Table 7. Link Input for MSAT and Criteria Idling Emissions Calculation.

Inputs	Values	Units
District	Dallas	-
Analysis Year	2021	-
Analysis Periods	AM Peak and PM Peak	-
Analysis Period Duration	6 hours	-
Pre-project Analysis Period Delay	65	vehicle-hours
Post-project Analysis Period Delay	30	vehicle-hours
Reduction in Analysis Period Delay	35	vehicle-hours

Based on the example project input provided in Table 7, filter the Idling ERLT only to keep Dallas district and year 2021 values. Emission reductions can then be obtained from the filtered ERLT using the following equations:

$$\textit{Emissions (grams/analysis period)}_{\textit{Pre-Project}} = \textit{Emission Rate (grams/hour)} * 65 \textit{ (vehicle-hours/analysis period)}$$

$$\textit{Emissions (grams/analysis period)}_{\textit{Post-Project}} = \textit{Emission Rate (grams/hour)} * 30 \textit{ (vehicle-hours/analysis period)}$$

$$\textit{Emissions (grams/analysis period)}_{\textit{Reduction}} = \textit{Emission Rate (grams/hour)} * (65 - 30) \textit{ (vehicle-hours/analysis period)}$$

Table 8 shows the emission rates from the filtered ERLT and the subsequent post-project emission reduction obtained for the analysis intersection.

Table 8. MSAT and Criteria Pollutants Idling Emission Calculations.

Pollutant Category	Pollutant	Dallas 2021 Emission Rates (grams/hour)	Reduction in Delay (vehicle-hours)	Reduction in Emissions (grams/analysis-period)
Criteria Pollutants	CO	4.687609	35	164
	NO_X	1.894972	35	66
	SO_2	0.025847	35	1
	NO_2	0.239215	35	8
	CO_{2EQ}	3,918.962937	35	137,164
	VOC	1.449034	35	51
	PM_{10}	0.111242	35	4
	$PM_{2.5}$	0.100990	35	4
MSAT	BENZ	0.016550	35	1
	NAPTH	0.002130	35	0
	BUTA	0.002321	35	0
	FORM	0.019106	35	1
	ACTE	0.009948	35	0
	ACROL	0.001226	35	0
	ETYB	0.022857	35	1
	DPM	0.073020	35	3
	POM	0.001096	35	0

2.4 Extended Idling Emissions for MSAT and Criteria Pollutants

The extended idling ERLT provides emission rates for MSAT and criteria pollutants for combination long-haul truck/18-wheeler (MOVES vehicle type 62). The criteria pollutants can be used to estimate emissions for grant applications and other various planning purposes. However, it is recommended to contact the MPOs where the project resides to get the latest emission rates. The units of rates are grams/hour. It can be used to estimate emissions using the following formula:

$$\textbf{Emissions (grams/day)}_{\textit{process type}} = \textbf{Emission Rate (grams/hour)}_{\textit{process type}} * \textbf{Idling time (hours/day)}$$

Where process type can be selected as APU (extended idling using auxiliary power unit) or Extnd_Exhaust (extended idling using the truck engine).

An example calculation is provided below to demonstrate the application of the extended idling exhaust emission rates for quantifying the emission for a project.

2.4.1 Example for Estimating Extended Idling Emissions

A city in the Dallas district is interested in assessing the daily emissions from extended idling at a truck stop near the interstate facility in the current year (2021). Field data from the truck stop shows that, on average, 50 trucks stop for rest at the truck stop—a truck rest for 10 hours on average. Twenty percent of the trucks use an auxiliary power unit during idling, while the remaining trucks use the truck engine for idling. Table 9 shows the project inputs.

Table 9. Link Input for Extended Idling Emission Calculations.

Inputs	Values	Units
District	Dallas	-
Analysis Year	2021	-
Hotelling Hours	10	hours/ truck
Total Trucks	50	trucks
Percent of Trucks with APU	20	percent

Based on the example project input provided in Table 9, filter the Extended Idling ERLT only to keep Dallas district and year 2021 values. Emission reductions can then be obtained from the filtered ERLT using the following equations:

Daily Hotelling hours using APU = 50 * 10 * (20/100) = 100 truck-hours

Daily Hotelling hours using truck engine = 50 * 10 * (80/100) = 400 truck-hours

$$\textit{Emissions (grams/day)}_{APU} = \textit{Emission Rate}_{APU}\ \textit{(grams/hours)} * 100\ \textit{(truck-hours)}$$

$$\textit{Emissions (grams/day)}_{Extnd\_Exhaust} = \textit{Emission Rate}_{Extnd\_Exhaust}\ \textit{(grams/hours)} * 400\ \textit{(truck-hours)}$$

Table 10 shows the emission rates from the filtered ERLT and the truck stop's emissions.

Table 10. MSAT and Criteria Pollutants Extended Idling Emission Calculations.

Pollutant Category	Pollutant	APU Emission Rate (grams/ hour)	Daily Hotelling hours—APU (truck-hours)	Extnd_ Exhaust Emission Rate (grams/ hour)	Daily Hotelling hours—truck engine (truck-hours)	APU Emissions (grams/ day)	Extnd_ Exhaust Emissions (grams/ day)	Total Emissions (grams/ day)
Criteria Pollutants	CO	36.000	100	89.272	400	3,600	35,709	39,309
	NO_X	27.929	100	207.662	400	2,793	83,065	85,858
	SO_2	0.013	100	0.055	400	1	22	23
	NO_2	1.592	100	69.228	400	159	27,691	27,850
	CO_{2EQ}	2,012.030	100	9,729.878	400	201,203	3,891,951	4,093,154
	VOC	7.533	100	32.431	400	753	12,972	13,726
	PM_{10}	1.856	100	1.184	400	186	474	659
	PM_{25}	1.708	100	1.089	5,562	171	6,059	6,229
MSAT	BENZ	0.059	100	0.380	400	6	152	158
	NAPTH	0.068	100	0.474	400	7	190	196
	BUTA	0.022	100	0.042	400	2	17	19
	FORM	0.589	100	5.991	400	59	2,396	2,455
	ACTE	0.268	100	1.991	400	27	796	823
	ACROL	0.050	100	0.299	400	5	119	124
	ETYB	0.020	100	0.177	400	2	71	73
	DPM	1.856	100	1.184	400	186	474	659
	POM	0.026	100	0.057	400	3	23	25

2.5 Start Emissions for MSAT and Criteria Pollutants

The extended idling ERLT provides emission rates for MSAT and criteria pollutants. The criteria pollutants can be used to estimate emissions for grant applications and other various planning purposes. However, it is recommended to contact the MPOs where the project resides to get the latest emission rates. The units of rates are grams/start. It can be used to estimate emissions using the following formula:

Emissions (grams/day)**$_{\textit{vehicle type, fuel type}}$ **=
Emission Rate (grams/start)**$_{\textit{vehicle type, fuel type}}$ *** No. of Starts (start/day)

An example calculation is provided below to demonstrate the application of the start exhaust emission rates for quantifying the emission for a project.

2.5.1 Example for Estimating Start Emissions

A city in Dallas plans to buy ten new buses to increase bus frequency (reduce bus headway) for some bus routes. This project will increase the bus number at the origin bus depot from 100 to 300 daily starts. The project would be finished by Fall 2021. Table 11 shows the project details. Post-project emission estimates are required for criteria pollutants and MSAT for the year 2021.

Table 11. Input for Start Emissions Calculation.

Inputs	Values	Units
District	Dallas	-
Analysis Year	2021	-
Daily Pre-project Bus-Depot Starts	100	vehicle-starts
Daily Post-project Bus-Depot Starts	300	vehicle-starts
Increase in Daily Bus-Depot Starts	200	vehicle-starts

Based on information in Table 11, filter the Start ERLT only to keep transit bus vehicle type, diesel fuel type, Dallas district, and year 2021 values. Emission increase can then be obtained from the filtered ERLT using the following equations:

$$\textit{Emissions (grams/day)}_{\textit{Pre-Project}} = \textit{Emission Rate (grams/start)}_{\textit{Transit Bus, Diesel}} * 100\ \textit{(vehicle-starts)}$$

$$\textit{Emissions (grams/analysis period)}_{\textit{Post-Project}} = \textit{Emission Rate (grams/start)}_{\textit{Transit Bus, Diesel}} * 300\ \textit{(vehicle-starts)}$$

$$\textit{Emissions (grams/analysis period)}_{\textit{Increase}} = \textit{Emission Rate (grams/start)}_{\textit{Transit Bus, Diesel}} * (300 - 100)\ \textit{(vehicle-starts)}$$

Table 12 shows the emission rates from the filtered ERLT and the subsequent emission increase for the bus depot.

Table 12. MSAT and Criteria Pollutants Start Emission Calculations.

Pollutant Category	Pollutant	2021 Dallas Diesel Transit Bus Emission Rate (grams/start)	Increase in Daily starts (vehicle-starts)	Increase in Emissions (grams/day)
Criteria Pollutants	CO	6.313990	200	1,262.8
	NOX	0.000000	200	0.0
	SO2	0.000692	200	0.1
	NO2	0.000000	200	0.0
	CO2EQ	118.052950	200	23,610.6
	VOC	0.339482	200	67.9
	PM10	0.010715	200	2.1
	PM25	0.009858	200	2.0
MSAT	BENZ	0.003448	200	0.7
	NAPTH	0.004203	200	0.8
	BUTA	0.000661	200	0.1
	FORM	0.048198	200	9.6
	ACTE	0.017318	200	3.5
	ACROL	0.002773	200	0.6
	ETYB	0.001468	200	0.3
	DPM	0.010715	200	2.1
	POM	0.000782	200	0.2

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